reported that they were anxious that elephants might raid their crops, damage their property or harm them.

Fire crackers and catapults were the most popular measures used by households to ward off elephants (used by 55.2% of respondents). Almost one-third of respondents had also built a hut to guard their crops at night. Other measures households used included un-electrified or electrified fences and lamps to light their crops. The total cost of the mitigation measures employed by households was THB 5,917 or USD 197 per household per year. While the opportunity cost of guarding crops at night was THB 7,632 or USD 254 per household per year. Overall, the total cost of HECs to households was approximately THB 48,374 or USD 1,612, which accounted for 26% of annual household income.

Which is the best Policy Option?

The study finds that policy Option 3 (which would involve habitat improvement, female elephant contraception and the use of electric fences) would be the most efficient option, with a net present value of up to 607.3 million THB (20.2 million USD). Under this option, habitat improvement activities would reduce the annual growth rate of the crop-damaged areas by about 20%, while electric fences could reduce crop damage by 80%. Option 3 is also the preferred option by the community members based on household survey results.

Households Willing to Help

When respondents in the survey were asked whether they would be willing to volunteer to work to improve habitats for elephants, 93% said that they would be willing to do so. Many respondents said that, as they have to pay for their own HEC mitigation costs, they would be willing to do volunteer work in the KARN wildlife sanctuary if this would reduce their costs. More than half of respondents (60%) stated that they did not hate the elephants but that they also did not want them to raid their crops. These attitudes indicate that local people are willing to support and take part in possible future HEC mitigation measures.

The study also found that there were some things that the local people were doing that were encouraging elephants to come out of the KARN wildlife sanctuary. For example, elephants did not eat papaya in the past but papaya vendors have been throwing over-ripe papayas on the road. Wild elephants have learned to eat the papayas and now raid the papaya crop. The study therefore recommends that an education campaign should be put in place to advise people not to feed wild animals.

Elephant Relocation May be Necessary in Future

The results of this study will be useful for policy makers and will help them select which policy intervention to employ in pilot PES schemes in the future. However, the study notes that habitat improvement, female elephant contraception and electric fences are medium-term solutions and that if the mitigation measures proposed in policy Option 3 are put in place, then the HEC problem will be only reduced and not eliminated. The study warns that in the future, even if the habitat in the KARN wildlife sanctuary is improved to its full capacity potential, the sanctuary will not be able to support its increasing elephant population forever, given the current growth rate of this population. Other research has recommended that the relocation of the sanctuary's entire elephant herd to a suitable area should therefore be considered. Because of this, the study concludes that the time may soon come when the relocation of the elephants should be discussed and researched, although it cautions that this would not be currently acceptable to the Thai people.

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The Economy and Environment Program for Southeast Asia (EEPSEA) was established in May 1993 to support training and research in environmental and resource economics across its 9 member countries: Cambodia, China, Indonesia, Laos, Malaysia, Papua New Guinea, the Philippines, Thailand, and Viet Nam. Its goal is to strengthen local capacity for the economic analysis of environmental problems so that researchers can provide sound advice to policymakers.

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How to Reduce Human-Elephant Conflicts – A Case Study from Thailand

EEPSEA POLICY BRIEF • No. 2011-PB14

In Thailand the number of elephants are declining, and many of the remaining animals are protected in a network of wildlife sanctuaries. Unfortunately, elephants from these protected areas are coming into conflict with farmers. This human-elephant conflict (HEC) is causing crop damage. It is also leading to injury and loss of life amongst both farmers and elephants. Now a new EEPSEA study has →

A summary of EEPSEA Research Report No. 2011-RR14: 'Analysis of Policy Options to Convert Human-Elephant Conflict into Human-Elephant Harmony' by Rawadee Jarungrattanapong and Siriporn Sajjanand, Sukhothai Thammathirat Open University, Tambon Bang Pud, Amphoe Pakkret, Nonthaburi 11120 Thailand.
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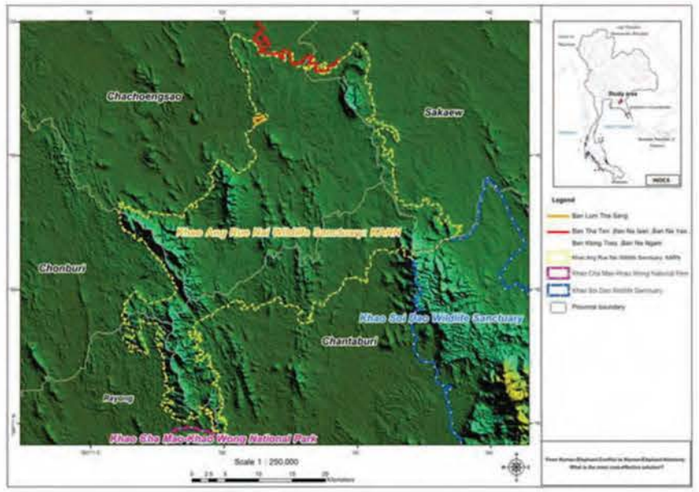
"The results will help ... select which policies to employ"



KARN wildlife sanctuary and the study areas

looked at this problem and has highlighted a combination of policies that should help to reduce it. The study is the work of Rawadee Jarungrattanapong, from the Ritsumeikan Asia Pacific University and Siriporn Sajjanand, from the Sukhothai Thammathirat Open University. It finds that improving the elephants' habitat, providing female elephants with contraception and using electric fences to keep elephants away from farmland would be the best combination of policies to mitigate HEC. It also finds that, in the long term, elephant relocation may be necessary in some areas.

The HEC Challenge

Thailand's population of around 2,500-3,000 Asian elephants are of immense cultural and environmental importance. As mentioned, elephant conservation is focused on keeping the animals safe in protected areas. Problems with this policy have arisen as some of the sanctuaries have only limited food and water resources. This forces elephants from the protected areas to venture into surrounding villages and croplands. As elephant populations in some protected areas are increasing, HEC is becoming more frequent. Despite this, there is little information available on the cost of the damage caused by the HEC problem in Thailand.

This study set out to provide valuable information on this key conservation issue and to see whether HEC could be reduced in a cost-effective manner. To select the most effective method of alleviating the conflict between humans and elephants, the study used a cost-benefit analysis (CBA) to highlight the best policy options. This research was part of a larger piece of research, a pilot project on Payment for Ecosystem Services (PES) for biodiversity conservation, which was conducted by Sukhothai Thammathirat, of the Open University, Thailand.

The HEC Study Area

The Khao Ang Rue Nai (KARN) Wildlife Sanctuary is one of seven protected areas in Thailand that harbor more than 100 elephants. It is also the location of some of the country's worst HEC. The KARN wildlife sanctuary covers an area of 1,079 km² of lowland rainforests across five provinces (Chachoengsao, Chonburi, Rayong, Chanthaburi and Sakaew) in the East of Thailand. It is surrounded by farmland.

In 2007, the estimated elephant population in the KARN wildlife sanctuary was approximately 217 and the crude elephant density was 0.2 animals per km². The wild elephant population has been expanding at a rate of 9.83% per annum in recent years. The elephant population in the sanctuary is expanding primarily because there are no natural predators for the elephants, such as tigers, in the sanctuary.

Looking at Policy Alternatives

In the villages in and around the study area, local people and government agencies have put some mitigation measures in place. However they have failed to eliminate the HEC problem. Elephant experts suggest that habitat improvements in the –KARN wildlife sanctuary could make it more hospitable to the elephants. The theory is that this would remove any incentive for the elephants to leave the protected area. The experts also suggest a range of other options that could be considered, including the use of contraception for female elephants, land-use changes and electric fences.

In light of these recommendations, the study assessed the costs and benefits of three main policy approaches: Option 1 - habitat improvement and female elephant contraception; Option 2 - habitat improvement, female elephant contraception and land-use change; and Option 3 - habitat improvement, female elephant contraception and the use of electric fences. These options were compared with the status quo.

In these policy groups, proposed habitat improvement measures included increasing the number of ponds, increasing the number of salt/mineral licks and increasing the amount of grassland present in the KARN wildlife sanctuary. Under the proposed plans, birth control for female elephants would be introduced when the elephant population exceeds the sanctuary's maximum capacity level of 500 elephants. Land-use change would involve the area within 0.5 km of the sanctuary's boundary. This area is a high-risk zone for elephant crop raiding, so its existing food crops would be changed to crops that are unpalatable to elephants. The proposal for electric fences would involve the construction of 220km of the barriers to protect high-risk areas.

Six Villages Take Part in a Household Survey

A household survey was used to obtain information on the attitude of households towards the impact of HEC and crop damage by raiding elephants and also to find out what mitigation measures households had taken. The household survey covered 200 households in six villages adjacent to the sanctuary that had been affected by HEC: namely Na Yao, Na Isan, Lum Tha Sang, Tha Ten, Na Ngam and Klong Toey.

Information on the costs of mitigation measures was obtained from a review of documents, a review of literature and expert interviews. The potential benefits of the policy options were assessed by looking at the costs that households would avoid if the policy measures were successfully implemented. These 'avoided costs' included the cost of property and crop damage, the cost of the protection mechanisms and the opportunity cost of time it took households to guard against elephants. It should be noted that the cost-benefit analysis conducted in this study underestimates the benefits of reducing HEC because it does not put a value on the human or elephant lives saved.

Costs and Mitigation Measures

The study found that the average number of crop-raiding incidents across all six study areas was roughly 25 per month. Households spent an average of 212 nights per year guarding crops. The average crop area damaged by elephants in 2010 was approximately 6 rai per household per year or 0.96 hectare per household per year. The average total cost of damage due to elephants in 2010 was approximately THB 34,825 per household per year or USD 1,161, which accounted for roughly 19% of average household income. HECs did not just cause direct costs, such as crop and property damage, but also led to the loss of life (as reported by one respondent in Na Yao village) and to two injuries. Additionally, 89% of respondents

Scenarios	Discount rate: 3%, Growth rate of crop-raiding cost: 5%	3%, 10%	3%, 15%	5%, 5%	5%, 10%	5%, 15%	8%, 5%	8%, 10%	8%, 15%
Status quo	-582.5 (-19.4)	-786.9 (-26.2)	-1160.2 (-38.7)	-489.4 (-16.3)	-646.4 (-21.5)	-928.9 (-30.9)	-387.6 (-12.9)	-495.8 (-16.5)	-685.7 (-22.9)
Policy 1:Habitat improvement and contraception	-32.2 (-1.1)	97.8 (3.3)	373.9 (12.5)	-31.6 (-1.1)	65.6 (2.2)	270.2 (9.0)	-30.0 (-1.0)	34.0 (1.1)	167.0 (5.6)
Policy 2: Habitat improvement, contraception and land use change	-915.3 (-30.5)	-710.8 (-23.7)	-337.6 (-11.1)	-788.3 (-26.3)	-631.2 (-21.0)	-348.8 (-11.6)	-646.2 (-21.5)	-538.0 (-17.9)	-348.1 (-11.6)
Policy 3: Habitat improvement, contraception and electric fences	64.0 (2.1)	253.5 (8.4)	607.3 (20.2)	43.6 (1.5)	188.7 (6.3)	455.6 (15.2)	22.5 (0.7)	121.9 (4.1)	300.4 (10.0)

Note: USD 1 = THB 30

Net present values of the net benefits of the three policy options (unit: million THB/million USD)